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A Proven Ground System Architecture for Promoting Collaboration and Common Solutions at NASA

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GSAW 2005

Manhattan Beach, California

February 28 - March 3, 2005

The abstract for this presentation was approved in late November and early December 2004.

It represents an update to the approved presentation given at the same conference in 2004. The purpose this year is to report that the system is maturing and going operational – no detailed design information is included.

A handwritten signature in black ink, appearing to read 'Dan Smith', is positioned above the printed name.

Dan Smith

301-286-2230



Ground System Architectures Workshop

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NASA/GSFC's Common Mission Operations Center Architecture

- Requirement: Improve how NASA develops and maintains ground data systems for dozens of missions, with a couple new missions always in the development phase.
- Decided in 2001 on enhanced message-bus architecture
 - Users offered choices for major components
 - They plug and play because key interfaces are all the same
 - Can support COTS, heritage, and new software
 - Even the middleware can be switched
- Project name: GMSEC
 - Goddard Mission Services Evolution Center



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NASA/GSFC Common Ground System Architecture

- Four Key System Concepts
 1. Standardize interfaces (not components)
 2. Utilize a messaging middleware to develop a framework
 3. Provide the user with choices for major functional components
 4. Own the reference architecture and interface standards, allow vendors and development organizations to own and advance their functional areas

- Progress reports have been provided at GSAW each year
 - 2003: Message bus design concept, prototype starting
 - 2004: Lab working, developing infrastructure for real missions
 - 2005: Operational missions, more on the way, many new benefits being realized (We are convinced!)



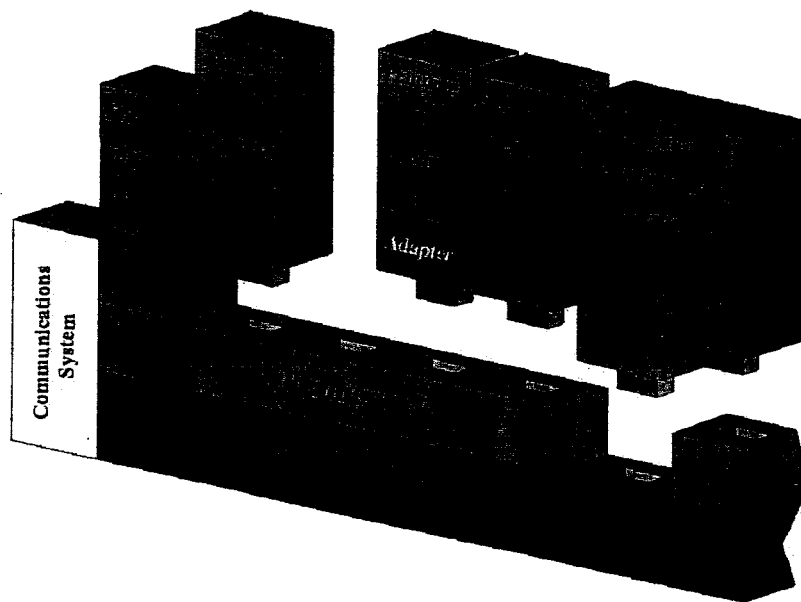
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Plug-and-Play Concept

By creating a "framework", individual applications can be easily integrated into a working system without regard to many underlying system traits.



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Operational Status

- Dozens of components now available
- 5 middleware package choices
- Automated test package for 8,000+ combinations including platforms and 4 languages
- Full documentation set
- GMSEC-based systems completed for several missions
 - Tropical Rainforest Measuring Mission
 - Goal to reduce ops costs by 50%
 - Pathfinder for TERRA, AQUA and AURA missions (now planned)
 - NASA Small Explorer (SMEX) Program
 - 4 satellites, moving towards fleet operations
 - Pathfinder for additional space science missions (now being designed)

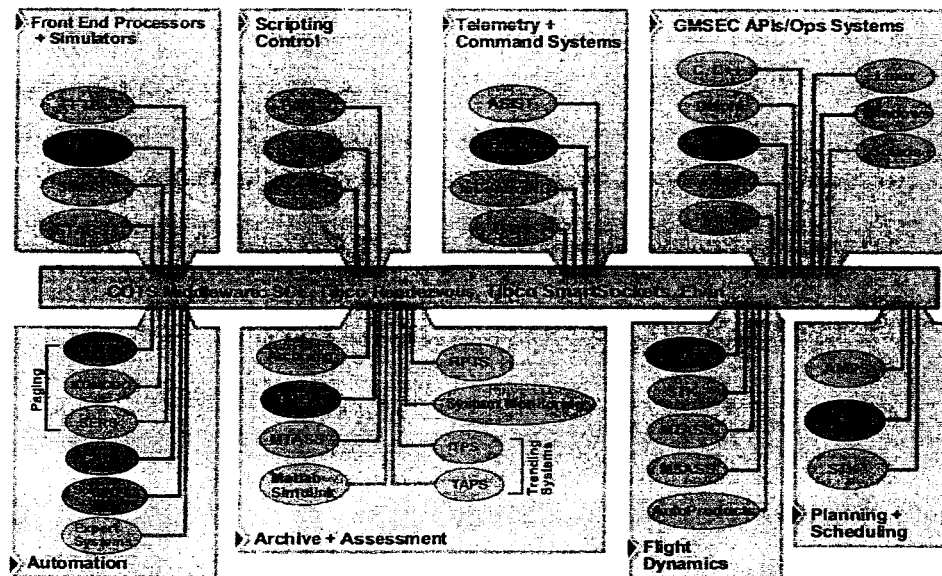


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GMSEC Component Catalog



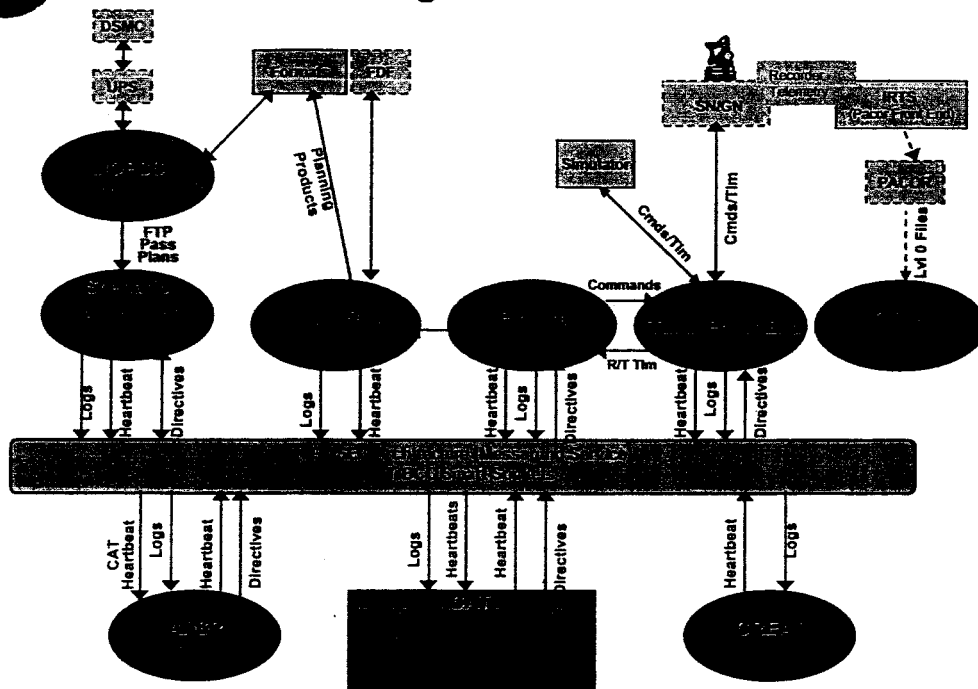
Choices are available for many subsystems. The TRMM mission selected catalog components to best meet their reengineering needs.



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TRMM Logical Architecture



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Example of What is Now Easy

- **System-Wide Automation**
 - Monitor bus traffic, take action based on defined rules
 - Crosses boundaries of all component domains
- **System Monitoring**
 - Subscribe to all bus traffic
 - Graphically show bus loading by category
- **Configuration Display**
 - Monitor heartbeat messages and selective text messages
 - Update graphical configuration display in real-time
- **Failovers**
 - Bus and component failover supported by middleware
 - Socket connections automatically re-established transparent to component or user

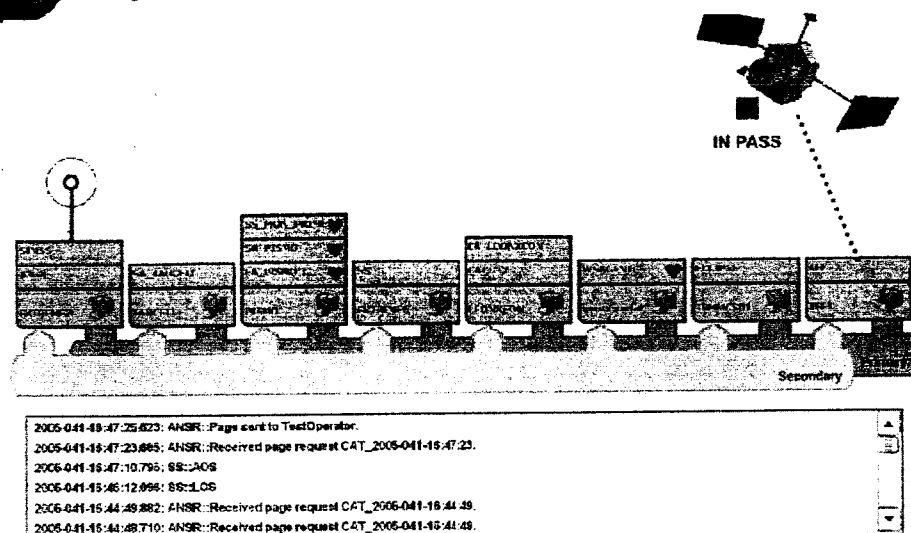
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Dynamic Bus-Based Configuration Display



Tool subscribes to event messages and heartbeats. Different event messages trigger updates to the display to show start of data flows, pager notifications, software and processor failures, etc. Sound effects for key alarm conditions, failovers, etc. All done with message subscriptions, no integration directly with other components.



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Observed Benefits

1. Significant reduction in integration time
2. Components added/upgraded without impacting existing system
3. Ideal for using multiple small development teams and vendors
4. Many suggestions are being made for small independent components that simply integrate with the bus to provide immediate benefits
5. Missions more willing to adopt the approach if "old favorite" components can still be used
6. Some vendors see message compliance as a way to finally enter what had appeared to be a closed marketplace
7. Standard message approach opens up collaboration possibilities with other organizations



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GMSEC and Common Solutions

- The GMSEC architecture provides a common solution for missions at NASA/GSFC
 - It is equally applicable to reengineering efforts for old missions and to new missions being developed
 - GMSEC team is currently working with about 10 different missions (old and new) on either design or integration efforts
- “Common Solution” is not the same as “Identical Solution”
 - Missions may have significant overlap in their needs
 - Requirements differences and user preferences may lead to the selection of different components in some functional areas
 - Some tools grow in popularity and become “common solutions” due to common usage across missions



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GMSEC and Collaborations

- The message bus and standard message approach facilitates common solutions and collaboration
 - If you match the standards and use the APIs, then you can probably develop a working component
 - A software developers kit provides needed documentation, APIs, simple middleware system and test routines to support development at remote sites
- Allowing other to integrate their components increases buy-in, and encourages collaboration
- Product vendors enthusiastic about GMSEC approach
- NASA's new Exploration Initiative considering many of the GMSEC concepts



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Final Note

With NASA's GMSEC,

- we've worked with many of the industry's product vendors
- we've been open with the contractor community
- we've proven our approach over multiple systems

We are now looking at open sourcing and/or standardizing much of GMSEC to encourage further common use, component sharing and collaborative development efforts.



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